

OPTICAL SENSOR UNIT, OPTICAL SENSOR ARRAY, AND METHOD  
OF DRIVING OPTICAL SENSOR

BACKGROUND OF THE INVENTION

5 Field of the Invention

The present invention relates to an optical sensor unit for performing image photographing using an optical sensor, an optical sensor array, and a method of driving the optical sensor.

10 Related Background Art

In recent years, a digital still camera and a digital video camera have been widely available because they have a characteristic in which a video obtained by photographing can be readily viewed at a photographing location and a characteristic in which  
15 an image is stored in a hard disk of a personal computer and can be read using a monitor when necessary. In many cases, an optical sensor mounted to the digital cameras is composed of a solid-state image pickup element of a MOS structure including a  
20 metal, oxide, and semiconductor in which photoelectric conversion is made possible. The solid-state image pickup element is classified into an FET type and a CCD type according to an optical  
25 carrier moving system. In addition, those types of solid-state image pickup elements are used in various fields such as a copying machine and a scanner in

addition to the above-mentioned cameras.

As shown in Fig. 24, the optical sensor includes a large number of optical sensor elements 21 arranged in matrix within an area 24 which receives  
5 light related to a video. A driver circuit which is composed of a column circuit 25 and a row circuit 26 transmits/receives signals to/from the respective optical sensor elements 21 through respective wirings 22 and 23, thereby producing the entire image data.

10 For example, Fig. 25 shows a two-dimensional CMOS area sensor having pixels of two columns and four rows, which is described in the first embodiment in Japanese Patent Application Laid-Open No. 2000-004399. According to a CMOS circuit disclosed in  
15 Japanese Patent Application Laid-Open No. 2000-004399, timing signals for image recording are sent from a vertical scanning block circuit and a horizontal scanning block circuit to respective CMOS sensor elements through respective wirings and then pixel  
20 signals are read out therefrom. Therefore, the optical sensor represented by the solid-state image pickup element such as a CMOS sensor or a CCD sensor which has been used up to now has a structure in which electrical wirings run in matrix to connect at  
25 least two driver circuits with the respective optical sensor elements.

On the other hand, when a 180° or 360°

panoramic picture is photographed, it is desirable that the optical sensor elements are formed on a curved substrate. Therefore, it is required that the optical sensor has a structure which is resistant to deformation such as bending. In addition, a use in which an object is photographed as a three-dimensional stereoscopic video and published on Web is increased. In addition, according to the optical sensor which has been used up to now, for example, the optical sensor disclosed in Japanese Patent Application Laid-Open No. 2000-004399 as described above, light sensitivity is uniformly adjusted for the entire substrate.

Because each optical sensor is formed on the same flat substrate, an angle with respect to a subject is constant. Accordingly, when a region wider than the view angle of a wide angle lens is photographed, it is required that images in respective portions are photographed in advance and the photographed images are synthesized.

Also, when a single subject is photographed from different angles, it is necessary to change both the position and the orientation of the optical sensor for photographing as in the above-mentioned case. In addition, synthetic processing is required after the photographing. In the synthetic processing, positioning and sensitivity matching of respective

images for keeping the continuity thereof are difficult. Therefore, there is a problem in that the synthetic processing is difficult.

Also, the entire sensitivity is determined in  
5 the conventional CCD sensor and the conventional CMOS sensor. Therefore, when a difference between a bright region and dark region in an image is large, it is necessary to adjust the sensitivity to either region. However, in this case, there arises the  
10 following problem. When the sensitivity is adjusted to the bright region, the dark region is difficult to view. When the sensitivity is adjusted to the dark region, the bright region uniformly becomes white.

#### 15 SUMMARY OF THE INVENTION

The present invention has been made in view of the above-mentioned problems, and an object of the present invention is to provide an optical sensor unit with high reliability in which the respective  
20 optical sensor elements can be easily provided on a curved surface without using wirings, a reduction in image pickup speed due to wiring delay is prevented to improve a photographing speed, and highly sensitive photographing is realized, an optical  
25 sensor array of the optical sensor unit, and a method of driving an optical sensor.

According to one aspect of the present

invention, an optical sensor unit includes: a plurality of radio optical sensor means each including an optical sensor and a radio element for transmitting and receiving of an information through communication with the optical sensor to and from an outside by radio; and radio communication means for transmitting and receiving an electromagnetic wave as a radio signal to and from the radio elements, which is located in a region apart from the radio elements, and in the optical sensor unit: the radio communication means transmits to each of the radio elements an electromagnetic wave as a signal for requesting transmission of photographing information and an electromagnetic wave for supplying energy for photographing by the optical sensor and radio transmission and reception by the radio elements; and each of the radio optical sensor means receives the electromagnetic waves and transmits photographing information of a subject from the optical sensor to the radio communication means through the radio element.

In further another aspect of the optical sensor unit, each of the radio optical sensor means is provided on a curved substrate and adapted to photograph the subject at different angles.

In further another aspect of the optical sensor unit, each of the radio optical sensor means is

provided on a cylindrical substrate and adapted to photograph a 360° image along a circumference of a cross section of the substrate.

In further another aspect of the optical sensor unit, each of the radio optical sensor means is provided on a spherical substrate and adapted to photograph an image in all directions.

In further another aspect of the optical sensor unit, the radio optical sensor means includes a plurality of position/direction detection elements for detecting positional information of the radio optical sensor means and directional information with respect to the subject and conducting communication to the radio elements, which are provided at different angles with respect to the subject; the radio optical sensor means communicates to the radio communication means photographed image information, the positional information, and the directional information to the subject; and the radio communication means synthesizes images of the subject from the respective information and displays the synthesized image.

In further another aspect of the optical sensor unit, the radio optical sensor means communicates information of light sensitivity to one another to optimize exposure.

In further another aspect of the optical sensor

unit, the radio elements have different values with respect to at least one of an inductance and a capacitance for each radio element, and the radio communication means transmits an electromagnetic wave  
5 having a different frequency to access each of the radio elements.

In further another aspect of the optical sensor unit, a digital modulation method selected from the group consisting of amplitude modulation, frequency  
10 modulation, and phase modulation is used as a method of imparting an instruction of a transmission request for the photographing information from the radio communication means to each of the radio elements.

In further another aspect of the optical sensor  
15 unit, the optical sensor includes a solid-state image pickup element composed of a CCD sensor or a CMOS sensor, and a lens.

According to another aspect of the present invention, an optical sensor array includes a  
20 plurality of radio optical sensor means each including an optical sensor and a radio element for transmitting and receiving of an information through communication with the optical sensor to and from an outside by radio, and in the optical sensor array, an  
25 electromagnetic wave as a signal for requesting transmission of photographing information and an electromagnetic wave for supplying energy for

photographing by the optical sensor and radio  
transmission and reception by the radio elements are  
received from the outside, and photographing  
information of a subject from the optical sensor is  
5 transmitted to the outside through the radio element.

In further another aspect of the optical sensor  
array, each of the radio optical sensor means is  
provided on a curved substrate and adapted to  
photograph the subject at different angles.

10 In further another aspect of the optical sensor  
array, each of the radio optical sensor means is  
provided on a cylindrical substrate and adapted to  
photograph a 360° image along a circumference of a  
cross section of the substrate.

15 In further another aspect of the optical sensor  
array, each of the radio optical sensor means is  
provided on a spherical substrate and adapted to  
photograph an image in all directions.

In further another aspect of the optical sensor  
20 array, the optical sensor array further includes a  
plurality of position/direction detection elements  
for detecting positional information of the radio  
optical sensor means and directional information with  
respect to the subject and conducting communication  
25 to the radio elements, which are provided at  
different angles with respect to the subject,  
photographed image information, the positional



information, and the directional information to the subject being transmitted to the outside.

In further another aspect of the optical sensor array, the radio optical sensor means communicate  
5 information of light sensitivity to one another to optimize exposure.

In further another aspect of the optical sensor array, the radio elements have different values with respect to at least one of an inductance and a  
10 capacitance for each radio element, and receive electromagnetic waves having different frequencies from the outside.

In further another aspect of the optical sensor array, the optical sensor includes a solid-state  
15 image pickup element composed of a CCD sensor or a CMOS sensor, and a lens.

According to another aspect of the present invention, a method of driving an optical sensor includes: arranging a plurality of radio optical  
20 sensor means independently of one another, which each include an optical sensor and a radio element for transmitting and receiving of an information through communication with the optical sensor to and from an outside by radio; arranging radio communication means  
25 for transmitting and receiving an electromagnetic wave as a radio signal to and from the radio elements in a region apart from the radio elements;

transmitting from the radio communication means to each of the radio elements an electromagnetic wave as a signal for requesting transmission of photographing information and an electromagnetic wave for supplying  
5 energy for photographing by the optical sensor and radio transmission and reception by the radio elements; and receiving from each of the radio optical sensor means the electromagnetic waves and transmitting the photographing information of a  
10 subject from the optical sensor to the radio communication means through the radio element.

In further another aspect of the method of driving an optical sensor, each of the radio optical sensor means is provided on a curved substrate and  
15 adapted to photograph the subject at different angles.

In further another aspect of the method of driving an optical sensor, each of the radio optical sensor means is provided on a cylindrical substrate and adapted to photograph a 360° image along a  
20 circumference of a cross section of the substrate.

In further another aspect of the method of driving an optical sensor, each of the radio optical sensor means is provided on a spherical substrate and adapted to photograph an image in all directions.

25 In further another aspect of the method of driving an optical sensor, the method further includes: arranging in the radio optical sensor means

a plurality of position/direction detection elements for detecting positional information of the radio optical sensor means and directional information with respect to the subject and conducting communication  
5 to the radio elements, which are provided at different angles with respect to the subject; transmitting from the radio optical sensor means photographed image information, the positional information, and the directional information to the  
10 subject to the radio communication means; and synthesizing by the radio communication means images of the subject from the respective information to display the synthesized image.

In further another aspect of the method of  
15 driving an optical sensor, the radio optical sensor means communicate information of light sensitivity to one another to optimize exposure.

In further another aspect of the method of driving an optical sensor, the radio elements have  
20 different values with respect to at least one of an inductance and a capacitance for each radio element, to thereby cause the radio communication means to transmit an electromagnetic wave having a different frequency to access each of the radio elements.

25 In further another aspect of the method of driving an optical sensor, a digital modulation method selected from the group consisting of

amplitude modulation, frequency modulation, and phase modulation is used as a method of imparting an instruction of a transmission request for the photographing information from the radio

5 communication means to each of the radio elements.

Thus, according to findings by the inventor of the present invention, in view of the above-mentioned problems, a large number of optical sensor elements are separately arranged and radio waves are  
10 transmitted to the respective optical sensor elements to drive them, so that respective wirings can be omitted and the optical sensor elements can be separately arranged. Because the respective elements are thus separated, the optical sensor can be  
15 arranged on an arbitrary curved body. Therefore, it is not required that photographing is conducted many times from different directions and then obtained images are synthesized.

Also, a single subject can be photographed from  
20 different directions and an image of wide angle from  $180^{\circ}$  to  $360^{\circ}$  can be photographed from a single location. In addition, because each of the radio optical sensor sections has a communication function, communication is conducted among them, so that the  
25 light sensitivity can be adjusted and a single image can be formed as a whole.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows an example of a circuit structure of a radio optical sensor unit of the present invention;

5        Fig. 2 shows an example of a structure of the radio optical sensor unit of the present invention;

Fig. 3 shows a radio optical sensor of the present invention;

10       Fig. 4 shows an example of a structure of the radio optical sensor unit of the present invention;

Fig. 5 shows an example of a structure of a radio optical sensor unit of the present invention;

Fig. 6 shows an example of a structure of a radio optical sensor unit of the present invention;

15       Fig. 7 shows an example of a structure of the radio optical sensor unit of the present invention;

Fig. 8 shows an example of a structure of a radio optical sensor unit of the present invention;

20       Fig. 9 shows an example of a structure of the radio optical sensor unit of the present invention;

Fig. 10 shows an example of a structure of the radio optical sensor unit of the present invention;

Fig. 11 shows an example of a structure of the radio optical sensor unit of the present invention;

25       Fig. 12 shows an example of a structure of the radio optical sensor unit of the present invention;

Fig. 13 shows an example of a structure of a

radio optical sensor unit of the present invention;

Fig. 14 shows an example of a structure of the  
radio optical sensor unit of the present invention;

Fig. 15 shows an example of a structure of the  
5 radio optical sensor unit of the present invention;

Fig. 16 shows an example of a structure of the  
radio optical sensor unit of the present invention;

Figs. 17A and 17B show examples of circuit  
structures of a radio optical sensor unit of the  
10 present invention;

Fig. 18 shows an example of a circuit structure  
of a radio optical sensor unit of the present  
invention;

Fig. 19 shows an example of a structure of a  
15 radio optical sensor unit of the present invention;

Fig. 20 shows an example of a structure of the  
radio optical sensor unit of the present invention;

Fig. 21 shows an example of a structure of a  
radio optical sensor unit of the present invention;

20 Fig. 22 shows an example of a structure of a  
radio optical sensor unit of the present invention;

Fig. 23 shows an example of a relationship  
among an antenna of a radio transmission section, a  
generated magnetic field, and a radio optical sensor  
25 in the radio optical sensor unit of the present  
invention;

Fig. 24 shows a circuit structure of a

conventional optical sensor; and

Fig. 25 shows a circuit structure of a conventional optical sensor.

5 DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, description will be made of optical sensor units as embodiments for explaining the present invention with reference to the drawings. (First Embodiment)

10 Fig. 1 is a schematic diagram showing a rough structure of an optical sensor unit according to a first embodiment of the present invention.

An optical sensor unit of this embodiment is composed of an image pickup area section 8 composing  
15 an optical sensor array in which a large number of radio optical sensors 3 are arranged and a radio communication means 4 located in the vicinity thereof. In the case of the image pickup area section 8 shown in Fig. 1, for example,  $3 \times 4$  radio optical sensors  
20 are arranged. However, it is sufficient that plural radio optical sensors are arranged and the number thereof is not limited to the example shown in Fig. 1.

The radio communication means 4 has an image data signal circuit 10, a radio transmission circuit  
25 9 connected therewith, and an antenna 7. When an image pickup command is outputted from an external control device which is not shown in the drawing, the

image data signal circuit 10 receives information at this timing, converts it into a format corresponding to the structure of the image pickup area section 8, and then sends the converted information to the radio transmission circuit 9. The radio transmission circuit 9 transmits image pickup timing information and energy required for image pickup as electromagnetic waves to the image pickup area section 8 through the antenna 7.

Each of the radio optical sensors 3 is composed of an optical sensor element 1, a radio element 2, and an antenna 6. Information transmitted from the antenna 7 of the radio communication means is received in the radio element 2 through the antenna 6. This information is sent to the optical sensor element 1. The image forming elements, which have received the ON information, forms an image which is displayed on the entirety of an image display section.

Hereinafter, an image pickup process will be briefly described.

First, a command for signal reply request is sent from the radio communication means to the respective radio elements. Upon reception of the command, the radio elements instruct an optical sensor section to output image pickup signals, and the optical sensor elements send pixel information through the radio elements to the radio communication



means. The radio communication means receives the information from the respective optical sensor elements.

Fig. 2 is a perspective view showing a structural example of the radio optical sensor unit of the present invention. A large number of radio optical sensors 3, each of which is a laminate of the radio element 2 and the optical sensor element 1 as shown in Fig. 3, are arranged on a substrate 5. In addition, the radio communication means 4 is provided in the vicinity of the radio optical sensors.

As shown in Fig. 4, an image generated from the optical sensor elements 1 may be changed into a color image by providing a color filter 11 of R (red), G (green), and B (blue).

Also, the antenna of the radio communication means and that of the radio element may be a coil shape as shown in Fig. 1 or a flat plate shape such as a shape of a dipole antenna, and a selection therebetween is made according to a frequency, a distance, and the like.

(Second Embodiment)

In the optical sensor unit of the first embodiment as shown in Figs. 1 and 2, electromagnetic waves or magnetic fields which are transmitted from the radio communication means 4 are simultaneously received in the plural radio optical sensors 3.

Several methods may be given as a method of communicating with the radio optical sensors.

For example, there is the case where the respective radio elements have different inductances  
5 or different capacitances from one another. A resonance frequency  $f_c$  is indicated using an inductance  $L$  and a capacitance  $C$  by the following expression (1).

$$f_c = 1/(2\pi(LC)^{1/2}) \quad \dots (1)$$

10 Therefore, it is set such that the respective radio elements have different resonance frequencies from one another, and radio waves with the set resonance frequencies are sent from the radio communication means 4 to elements for which image  
15 formation is required. Thus, photographing becomes possible and an arbitrary image can be formed as a whole.

Also, a digital modulation method such as amplitude modulation, frequency modulation, or phase  
20 modulation may be used. According to those methods, a carrier wave with a constant frequency is sent and one of three parameters of power, a frequency, and a phase in the carrier wave is changed to transmit information. Energy required for image pickup by the  
25 optical sensor elements can be sent using the carrier wave.

Also, the energy used for image pickup may be

supplied through energy supply wirings 12 as shown in Fig. 5 and only ON/OFF information for the optical sensor elements may be transmitted by radio. This is effective, for example, in the case where energy  
5 supplied using an electromagnetic wave is insufficient for image pickup operation of the optical sensor elements.

(Third Embodiment)

Fig. 6 shows a structural example of an optical  
10 sensor unit of this embodiment.

Radio optical sensors 51 are provided on a cylindrical substrate 52. In addition, a columnar radio communication means 4 is provided in the inner portion of the substrate, so that communication with  
15 the respective radio optical sensors can be conducted. The radio optical sensors are evenly arranged around the cylindrical substrate. Therefore, a 360-degrees image can be photographed.

Fig. 7 shows the case where a lens structure 53  
20 is provided to the optical sensor unit shown in Fig. 6. Figs. 11 and 12 show examples of antenna structures.

(Fourth Embodiment)

Fig. 8 shows a structural example of an optical  
25 sensor unit of this embodiment. Radio optical sensors 61 are laid on the entire surface of a spherical substrate 62. A radio communication means

4 which is not shown is provided in the inner portion of the spherical substrate 62, so that communication with the respective radio optical sensors 61 can be conducted. In addition, although not shown, the  
5 radio communication means communicates with an external control device such as a personal computer.

Fig. 9 is a schematic view showing a state in which a lens structure 65 is located outside of the optical sensor unit shown in Fig. 8.

10 This structure may be obtained by laying micro-lenses. Alternatively, as shown in Fig. 10, light may be condensed to a structure 68 in which radio optical sensors are laid through lens films 66 and 67 having different refraction indexes. In the figure,  
15 reference numeral 69 denotes a radio communication means.

(Fifth Embodiment)

As shown in Fig. 13, a radio communication means 4 may be provided in the lower side of a  
20 substrate 5. Therefore, distances between the radio communication means 4 and respective radio image forming elements are made uniform. In addition, because distances therebetween become shorter, there are the following advantages. That is, when radio  
25 transmission is conducted for the respective elements, sufficient energy can be transmitted thereto, ON information can be transmitted without fail, etc.

Also, as shown in Fig. 14, radio image forming elements 3 arranged on a transparent substrate 51 may be opposed to radio communication means 4 arranged on a substrate 52 so as to make each of the elements and each of the sections correspond to each other. In this case, a so-called spatial time-division multiplexing system in which distances between the radio communication means and radio image forming elements become shorter and separate communication can be spatially conducted for the respective elements can be used. Accordingly, interferences among the elements can be efficiently suppressed.

Also, the radio optical sensor unit shown in Fig. 14 may be improved to provide one radio communication means 4 for plural image forming elements 3, for example, four radio image forming elements 3 as shown in Fig. 15. Accordingly, a structure is further simplified. Fig. 16 shows a structure of an antenna taken out with respect to Fig. 15. An antenna 6 of the radio image forming element 3 is a spiral shape. A current flows according to a change in magnetic field, thereby generating a voltage between terminals 68 and 69. The radio communication means 4 has the same structure as the radio image forming element. A high frequency current is made to flow between terminals 78 and 79 of a spiral antenna 7, thereby providing a generated

magnetic field to the radio image forming element 3.  
(Sixth Embodiment)

Fig. 17A is a circuit diagram showing a circuit corresponding to the structure shown in Fig. 14.

5        As shown in Fig. 17A, an antenna 7 of a radio communication means 4 is a coil with an inductance L1 and an antenna 6 of a radio image forming element 3 is a coil with an inductance L2. The coils with inductances L1 and L2 are not physically in contact  
10 with each other and are magnetically coupled by a mutual inductance M. A resistance of the coil with the inductance L2 is indicated by R2.

A capacitor C2 is connected in parallel with the coil with the inductance L2 and set such that it  
15 is resonated at a frequency of a radio wave transmitted from the antenna 7. An optical sensor element 1 located in a region surrounded by a dotted line is connected in parallel with the capacitor. A diode D1 is located between the capacitor and the  
20 optical sensor element. Therefore, the polarity of alternating current is made single. Further, a low direct current voltage Vcc is produced by a Zener diode ZD1. This voltage is applied to necessary portions of the optical sensor element. In Fig. 17A,  
25 an example in which a CCD sensor is used as the optical sensor element is indicated.

Hereinafter, an operation example of the CCD

sensor will be described. Before reading signal charges from a photo diode PD, a potential  $\Phi_{RES1}$  to the gate of a reset MOS M1 is set to a high level. Therefore, the gate of an amplifying MOS M3 is reset  
5 to VR.

Next, a potential  $\Phi_{TX1}$  to the gate of a charge transfer switch TX becomes a high level, so that the photo signal charges from the photo diode PD are transferred to the gate of the amplifying MOS M3.  
10 Accordingly, a current corresponding to charges resulting from light detected by the photo diode is produced in V(1).

The current is inputted to the gate of a transistor T1 through a resistor R3, so that a  
15 resistance between the source and the drain of the transistor T1 located in parallel to the coil with the inductance L2 is changed. Accordingly, an amplitude of an electromagnetic wave sent from the coil with the inductance L2 to the radio  
20 communication means 4 is changed, thereby transmitting image pickup data to the radio communication section.

Note that, as shown in Fig. 17A, a voltage in VR connected with the drain electrode of the charge  
25 transfer switch TX and a voltage in VDD connected with the drain electrode of the amplifying MOS M3 are supplied from the above-mentioned Vcc. In addition,

similarly,  $\Phi TX1$  and  $\Phi RES1$  are supplied from  $V_{cc}$ .  
With respect to a timing of supply, circuit elements  
may be inserted between  $V_{cc}$  and  $TX1$  and between  $V_{cc}$   
and  $RES1$  so as to produce a time difference.

5           Therefore, a radio wave is transmitted from the  
radio communication means 4 to the radio optical  
sensor according to a timing of photographing, so  
that a radio wave whose amplitude is modulated  
according to the amount of light received in the  
10 photo diode PD can be retuned to the radio  
communication means.

Also, Fig. 17B shows a circuit structure  
showing an example in which the circuit shown in Fig.  
17A is improved.

15           In this case, a sub-carrier with a low  
frequency is produced from a transmitting frequency  
by a multi-stage binary counter 4024. For example, a  
sub-carrier with 212 kHz is produced from a  
transmitting frequency of 13.56 MHz. A voltage  
20 induced in the antenna coil with the inductance L2 is  
rectified using a bridge rectifier (D1 to D4) and  
then smoothed, so that it is used as power supplied  
to the circuit. In addition, a signal corresponding  
to the voltage induced in the antenna coil is passed  
25 through a protective resistor R4, so that it is used  
for a generating source for an internal clock signal.  
For example, in the case of Fig. 17B, the signal is



divided into the sixth power of 2 (= 64) and then a clock signal of the sub-carrier with 212 kHz is generated from Q7. On the other hand, an output signal V(1) from the optical sensor element 1 passes through a processing portion R3, processed using the sub-carrier by a NAND gate 7400, and arrived at a gate electrode of a transistor T1, and then the output signal V(1) modulated by T1 passes through a load resistor R5, and is transmitted from the antenna coil with the inductance L2. When the sub-carrier is used as in the case of the circuit shown in Fig. 17B, communication is improved.

(Seventh Embodiment)

The example of the communication mode using inductive coupling is described in the sixth embodiment. However, electromagnetic backscatter coupling may be used. Fig. 18 shows this example. In this case, an antenna of a radio communication means 4 and an antenna of a radio optical sensor 3 are a dipole antenna DA1 and a dipole antenna DA2, respectively. When the wave length  $\lambda$  of a communication radio wave is used, the communication distance is longer than a value indicated by  $\lambda/(2\pi)$ . It is preferable that a length of the antenna is set to  $\lambda/2$ . Alternatively, it is preferable that an end portion of the antenna is grounded and the length thereof is set to  $\lambda/4$ . Therefore, the resonance can

be made at a transmitting frequency to conduct the communication.

(Eighth Embodiment)

Fig. 19 shows an optical sensor unit of this  
5 embodiment. There are a large number of radio  
optical sensors 3 which are located at random. Radio  
communication is conducted for each of them and an  
image photographed by a radio optical sensor of the  
respective radio optical sensors is sent to a radio  
10 communication means 4.

Fig. 20 shows an optical sensor unit in which  
the antenna of the radio communication means 4 is  
improved and which has directivity.

(Ninth Embodiment)

15 Fig. 21 shows an embodiment of an optical  
sensor unit of the present invention. Radio optical  
sensors 3 of the present invention are located around  
an image pickup object 99. The plurality of radio  
optical sensors are located at different angles with  
20 respect to the object, and photographed image data  
are outputted from the elements to be sent to a radio  
communication means 4.

Further, an element for sensing positional  
information of the radio optical sensor and  
25 directional information with respect to the object is  
provided in each of the radio optical sensors.  
Accordingly, photographed image information,

positional information, and directional information with respect to the object which are outputted from each of the radio optical sensors can be transmitted to the radio communication means. Thus, it is  
5 possible that images of the object are synthesized based on those information by the radio communication means and a synthesized image is displayed.  
(Tenth Embodiment)

As shown in Figs. 22 and 23, according to an  
10 example in which a dipole antenna 7 is used in a radio communication means 4, a high frequency signal 44 is applied to the dipole antenna and a generated magnetic field B is supplied to a radio optical  
sensor 3. Because, an antenna 6 of the radio optical  
15 sensor is placed on a surface parallel to the dipole antenna 7, induced electromotive force is generated in the antenna 6 according to a variation in generated magnetic field B. When the induced  
electromotive force is led from terminals 68 and 69,  
20 an image can be formed by the radio optical sensor. Therefore, a sensor section 8 can have an image pickup function to the entire region. For example, a high frequency signal of 2.45 GHz is used as the high frequency signal 44 and a length of the antenna 7 is  
25 set to 5 cm to 6 cm corresponding to half the wavelength.

According to the present invention, there is

provided: an optical sensor unit with high  
reliability in which the respective optical sensor  
elements are provided on a curved surface without  
using wirings to prevent a reduction in image pickup  
5 speed due to wiring delay to achieve improvement in  
terms of the image pickup speed, whereby highly  
sensitive photographing is possible; an optical  
sensor array of the optical sensor unit; and a method  
of driving an optical sensor in the optical sensor  
10 unit.